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(54) IMPROVEMENTS IN VESSEL CARRIERS FOR CENTRIFUGES

(71) I, GUNTER EBERLE, a German citizen, trading as ANDREAS HETTICH, of Gartenstrasse 100, 7200 Tuttlingen, Germany, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a vessel carrier for receiving test vessels such as, for example, test-tubes for centrifuges, which carrier is pivotably suspended by means of pivot pins and bearing grooves in a centrifuge head.

The vessel carriers hithereto used for receiving several test vessels, for example, test-tubes, were machined from a solid block of light metal and either provided with individual blind hole bores of a diameter equal to that of a test-tube or with a substantially square recess for receiving a vessel holding frame. The vessel carriers which were only provided with individual blind hole bores, each for receiving one test-tube, had not only the disadvantage that they were very expensive because they had to be machined from a solid block in order to have the necessary strength, but they had a very large mass which during centrifuging resulted in exceedingly high centrifugal forces. A further drawback consisted in that for the protection of the test-tubes in the individual blind hole bores, rubber stoppers had to be inserted but nevertheless breakage of test tubes frequently occurred during centrifuging and the subsequent cleaning of the blind hole bore concerned was complicated and troublesome.

Even those vessel carriers which were proided with a substantially square hollow space for the simultaneous receiving of several test vessels with a vessel holding frame had to be machined from a solid block and were therefore expensive and heavy, that is, they also produced exceedingly high centrifugal forces which had to be counteracted by the bearing pivots. Due to these high centrifugal forces in both known types of construction, it was not even possible to make the bearing pivots separately as individual parts and insert them subsequently in the vessel carriers, because neither screw connections nor rivetting withstood the very great centrifugal forces. This meant that even the bearing pins had to be machined from solid material.

A further considerable disadvantage of the known vessel carriers is that because the vessel carriers are closed at the side and consist of non-transparent material, for the most part of steel, they prevent any view from the side of the lower part of the test-vessels. One has therefore to arrange the duration of centrifuging either according to experience or by trial and error tests in which the centrifuge has to be stopped several times and the individual test vessels removed for inspection. Of course this considerably disturbs the working cycle.

An object of the present invention is to provide a vessel carrier which obviates all these drawbacks, which is cheaper to produce, which is lighter and which is easy to handle. Furthermore it appertains to the object, to form the vessel carrier such that several test vessels, for example, test-tubes are insertable simultaneously battery-wise and are removable for further use. A vessel holding frame is also to be provided which allows all round viewing into the lower part of the test vessels in order to give the laboratory technicians the possibility of perceiving at a glance the result of the centrifuging in all test vessels without each vessel having to be removed individually.

Another object of the invention is to provide a vessel carrier which permits continuous observation of the material being centrifuged during the centrifuging thereof so that the duration of centrifuging is no longer dependent on estimated values or experience but may be made directly dependent on the effects of centrifuging that is, on the com-

plete depositing of sediment in the test vessels.

There is formed according to the invention a vessel carrier for receiving test vessels such as, for example, test-tubes for use in centrifuges, the carrier being capable of being pivotably suspended on a centrifuge head when the carrier is in use, the means of suspension including lateral bearing pins provided on the carrier and arranged to be located in bearing grooves in the said head, said carrier being characterised by a substantially U-shaped stirrup formed with a base plate provided with upstanding arms on which the bearing pins are mounted adjacent to the free ends of said arms, a beaker for insertion in a positive locking manner in said stirrup, a test vessel holding frame for insertion in said beaker, and said holding frame having walls formed with openings or windows in lower portions thereof.

The vessel carrier has substantial advantages compared with the arrangements known hithereto.

The stirrup which is supsended in a rocking manner in the head of the centrifuge and which during centrifuging has to take up all centrifugal mass forces is substantially more simple and cheaper to produce and it is substantially lighter so that the centrifugal forces to be resisted by the pivots are substantially less and allow a substantially higher centrifugal speed and a lighter construction of the centrifuge head. The beaker which is held in a positively locking manner in the stirrup, is likewise simple and cheap to produce, and is also of very light weight so that it does not contribute substantially to increasing the centrifugal forces. The actual object of this beaker is, in case of a breakage of a test vessel, to receive the vessel's contents as well as the broken material, for example, the glass fragments of a test-tube, and to take care that neither the liquid nor the vessel fragments are thrown into the centrifugal drum. In this way upon breakage of a test vessel occurring, the centrifugal drum is prevented from being soiled and an imbalance thereof prevented. As is known, several vessel carriers are simultaneously suspended symmetrical to their middle axis on the centrifuge head during each centrifuging procedure so that the centrifuging operation can be carried out as free from imbalance as possible.

The vessel holding frame which is inserted in the beaker and receives the individual test vessels batterywise has the advantage that simultaneously in a single operation several test vessels can be handled so that the mistaking of individual test vessels is substantially prevented. In addition, these vessel holding frames are very useful as stands for several test vessels and may be placed on a suitable storage surface before and after centrifuging. Due to the fact that the lower portions of the side walls of the vessel holding frames are formed with openings, this allows the laboratory technician a view at any time of all the test vessels and their contents so that it is not necessary to remove the individual vessels from the holding frame for visual examination. This vessel holding frame can also be made in a simple manner and cheaply. As it is only the base of the frame on which the test vessels stand that is subjected to the centrifugal forces of the test vessels and their contents, the vessel holding frame does not need to be particularly strong and may therefore be made, for example, of light plastics or of any other light material in a lightweight construction.

The vessel carrier according to the invention therefore has, compared with known arrangements used for the same purpose, the advantages that it is more simply made, and is cheaper and lighter. Also the handling of the test vessels is simplified and this saves work.

In a further embodiment of the invention, the stirrup and the base plate are made in one piece. This measure brings about a further cheapening and simplification of the manufacture.

According to the size of the stirrup, it may be expedient for the stirrup and the base plate to be made separately and the base plate screwed or otherwise positively connected to the stirrup.

Compared with the known vessel carriers in which the bearing pivots are machined in one piece from a solid block, in a further embodiment of the invention the bearing pivots are rivetted to or screwed into the arms of the stirrup. This measure likewise brings about further cheapening and simplification of the manufacture.

In a further advantageous construction of the invention, the stirrup is formed of plastics or light metal. It is expedient to provide the stirrup with an upper holding frame and to provide upright securing parts on the upper face of its base plate, these securing parts being, for example, bars, pins, flanges or the like for holding the beaker.

Thereby the beaker is securely held in a simple manner and it is not necessary to provide walls or other parts of the beaker with any holding sections with which it can be firmly held on the stirrup.

It is also expedient and advantageous to provide the base plate with a trough for receiving the under part of the beaker.

In a particularly advantageous embodiment of the invention the stirrup is constructed to receive several beakers and/or vessel holding frames.

It is thereby possible to accommodate in one stirrup several vessel holding frames of

standard size each in a separate beaker or collectively in a single large beaker.

In this latter embodiment the single large beaker is of a size which corresponds to the size of the stirrup, and in which beaker several smaller holding frames of standard size are inserted. Thereby a further cheapening and saving in weight accompanied by an increase in the number of test vessels suspended on the centrifuge head is attained.

The beaker itself has thin walls made from plastics material which is resistant to acids, lyes or other corrosive chemicals. Thus damage to the beaker is avoided if, for example, a test vessel breaks and its contents flows into the beaker.

In a very simple embodiment of beaker two opposite side walls thereof are formed with indenations for receiving the stirrup arms.

A very desirable feature is that the beaker should be formed of clear transparent synthetic material, for example, "Plexiglass" (Trade Mark). Thus it is not only possible for the contents of the individual test vessels to be observed from outside through the beaker wall and the lateral openings of the vessel holding frame, but it is also possible to continuously monitor the change in the state of the contents of the test vessels during cenutrifuging and utilize photo-electric means responsive to the change in transparency of the contents to control the centrifuge. This is because opaque sediment tends to accumulate at an end of a test vessel during centrifuging whilst the remaining contents become increasingly more clear and transparent.

Therefore in a further embodiment of the invention one or more photo converters are provided over the trajectory of the vessel carrier and one or more stroboscopic lamps provided under the trajectory and arranged to flash at a frequency adapted to the speed of the centrifuge.

The use of a stroboscopic lamp makes it possible to illuminate the contents of the vessels in the individual vessel carriers via the transparent beakers so that the illumination when detected photo-electrically triggers the automatic switching off of the centrifuge when the contents of the test vessels have been sufficiently centrifuged.

If desired the positions of the photo convertors and stroboscopic lamps can be interchanged, but it is particularly desirable that the photo convertor should be as near the trajectory as possible.

To increase the responsive sensitivity of the monitoring means it is preferred to provide two groups of photo convertors, one group responding to bright-dark reflection and the other group responsive to dark-bright reflection and both groups produce a control signal via logic circuitry.

The vessel holding frame can be suitably formed with a substantially square hollow body having side walls formed with openings, a floor and a solid upper part which is formed with through perpendicular bores arranged in rows, each bore being adapted to receive a test vessel.

The invention will now be further described with reference to the accompanying drawings:—

Fig. 1 is an exploded view in perspective of the three essential main components of a vessel carrier formed according to the invention, namely a stirrup, a beaker and a vessel holding frame;

Fig. 2 is a section on line A—A through a side wall of the beaker of Fig. 1;

Fig. 3 is a section through another embodiment of stirrup;

Fig. 4 is a section on line B—B in Fig. 3;

Fig. 5 is a section on line C—C in Fig. 3;

Fig. 6 is a perspective view of the components in Fig. 1 assembled together;

Fig. 7 is a view from above, on a smaller scale of a head of a centrifuge;

Figs. 8 and 9 are plan views of two different methods of mounting a plurality of vessel holding frames in vessel carriers formed according to the invention;

Fig. 10 is a perspective view of another embodiment of stirrup;

Fig. 11 is a section through a fragment of a base plate of another embodiment of stirrup;

Fig. 12 is a diagrammatic view of an arrangement of a photo converter and a stroboscopic lamp respectively disposed above and below the trajectory of the vessel carrier in the drum of a centrifuge.

Referring to Figs. 1, 2 and 6 the vessel carrier according to the invention comprises a U-shaped stirrup 1 having a base plate 2 and bearing pins 3 provided adjacent to upper ends of arms upstanding from the base plate, a beaker 5 and a vessel holding frame 6.

In Figs. 1 and 2 the stirrup arms 4 are welded to sides of the base plate 2 at positions substantially mid-way along the sides to form the stirrup. The beaker 5 is preferably formed of transparent plastics material and has relatively thin walls and thin base. This beaker is shaped to fit in the stirrup and opposite side walls 8 and 9 each formed with a groove 10 adapted to receive a stirrup arm 4 to prevent dislodgment of the beaker in either direction indicated by the double headed arrow 7 (Fig. 1) when the beaker is in position as shown in Fig. 6.

The holding frame 6 is relatively close fit in the beaker 5. The frame is substantially a hollow body of a cube or cuboid shape formed with windows or openings 11 in lower portions of its side walls. The frame has a base 12 and the upper part 13 of the

frame is formed with a plurality of substantially perpendicular through bores 14 disposed in rows to receive test vessels 15, for example test-tubes, which have lower ends resting on a loose cushion 16 on the base 12.

When it is wished to centrifuge the contents of the test vessels 15 to force solids to the closed ends of the vessels as sediments, the vessels are placed in the frame 6 which is then inserted into the beaker 5. The beaker is placed in the stirrup 1 to complete the vessel carrier which is then suspended like a swing on a head 17 on a centrifuge. This suspension is achieved by locating the pins 3 in grooves 18 formed on opposite sides of a recess 19 in the head.

After centrifuging is completed the whole carrier can be lifted off the head by a laboratory technician or only the beaker and frame can be removed from the stirrup and replaced by another beaker and frame containing further test vessels containing material to be centrifuged. By means of the windows 11 the technician can, before and after centrifuging, observe the appearance of the contents of the test vessels without removing individual vessels from the frame.

In the embodiment of stirrup 1^1 in Figs. 3, 4 and 5 a saddle part is bent into a U shape to provide arms 4^1 and a bridging piece 20 to which a base plate 21 is secured substantially centrally by screws 22. To ensure plate 21 is located firmly in place it is formed with recesses 23 which snugly and engageably receive the arms 4^1 provided with bearing pins 3^1 rivetted to the arms. In this embodiment welding work is unnecessary and the stirrup is formed of two parts, a base plate 21 and a U-shaped flexible part.

The further embodiment of stirrup 1^{11} in Fig. 10 is of a construction similar to that in Figs. 3 to 5 in that it has a U-shaped part bent from flat material to form two stirrup arms 28 interconnected by a bridging piece 27 to which a base plate 25 is secured by screws 26.

Besides carrying bearing pins 29 the arms 28 also mount a rail or frame 30. The stirrup 1^{11} is dimensioned to receive and support four vessel holding frames 6. Two different arrangements are shown in Figs. 8 and 9. In Fig. 8 each of the four holding frames 6 is mounted in an individual beaker 5 whilst in Fig. 9 the four frames 6 are all mounted in a common beaker 33. It should be understood however that a single large holding frame can be provided to occupy beaker 33 if desired.

The larger stirrup 1^{11} cannot be mounted on the same size of centrifuge head 17 as the smaller stirrup 1, and 1^1 consequently the larger stirrup is mounted on a larger head possibly on a larger centrifuge. Nevertheless the larger stirrup 1^{11} can be constructed to simultaneously support a plurality of the standard frames 6 and beakers 5 dimensioned for use with the stirrups 1 and 1^1.

As shown in Fig. 11, the base plate 25 can have a trough 31 secured thereto by screws. This trough is to hold and position the beaker or beakers mounted in the stirrup 1^{11}. As an alternative to the trough 31, flanges 32 can be mounted around the periphery of the base plate.

In Fig. 12 the head 17 is mounted in a centrifuge drum 35 closed by a lid 36. In this Fig. head 17 is shown rotating and carrying a vessel carrier constituted by the stirrup 1 containing the beaker 5 and the vessel holding frame 6 which contains test vessels 15. The beaker is transparent and formed, for example, of "Plexiglass" (Trade Mark) so that the contents of the test vessels are visible through the windows or openings 11. A photo convertor 37 is mounted in the lid 36 over and closely adjacent to the trajectory of the vessel carrier. A stroboscopic lamp 38 is mounted under the trajectory and directly below the photo convertor. This lamp is arranged to emit pulses or flashes of light, the frequency of the pulses being synchronised with the speed of the head 17 and to the number of vessel carriers so that each is illuminated by a flash as the carrier passes over the lamp.

The photo convertor has two groups of photo cells. One group 39 responds to bright-dark reflection and is disposed over the trajectory of the closed lower ends of the test vessels where non-transparent deposits of sediment 41 tend to accumulate. The other group of photo cells 40 is disposed over the trajectories of those parts of the vessels where clear liquid 42 is likely to occur after the sediment has accumulated at the closed ends. Cells 40 respond to dark-bright reflection. Thus the centrifuging process can be monitored as it occurs to determine the state of the contents of the vessels, that is the degree of accumulation of sediment 41 and the clarity of the liquid 42. The two groups of cells improve the sensitivity of the monitoring procedure and their responses can be combined by logic circuitry and switches to give a single control signal which is arranged when pre-determined electrical conditions are satisfied to trigger the halting of the centrifuge. Thus the duration of centrifuging is controlled automatically.

WHAT I CLAIM IS:—

1. A vessel carrier for receiving test vessels such as, for example, test-tubes for use in centrifuges, the carrier being capable of being pivotably suspended on a centrifuge head when the carrier is in use, the means of suspension including lateral bearing pins

provided on the carrier and arranged to be located in bearing grooves in the said head, said carrier being characterised by a U-shaped stirrup which includes a base plate provided with upstanding arms on which the bearing pins are mounted adjacent to the free ends of said arms, a beaker for insertion in a positive locking manner in said stirrup, and a test vessel holding frame for insertion in the beaker, said holding frame having side walls formed with through openings or windows in lower portions thereof.

2. A vessel carrier as claimed in Claim 1 in which the base plate and arms are formed as a non-dismantable one piece unit.

3. A vessel carrier as claimed in Claim 1 in which the base plate is rivetted, screwed or otherwise positively locked to the arms or materially attached to the arms, for example by welding.

4. A vessel carrier as claimed in any one of Claims 1 to 3 in which the bearing pins are screw mounted on the arms or rivetted to the arms.

5. A vessel carrier as claimed in any one of Claims 1 to 4 in which the stirrup is formed of plastics material.

6. A vessel carrier as claimed in any one of Claims 1 to 4 in which the stirrup is formed of light metal.

7. A vessel carrier as claimed in any one of Claims 1 to 6 in which the stirrup is provided with an upper frame mounted on the arms to surround one or more beakers inserted into the stirrup, and the base plate is provided with flanges for holding the inserted beaker or beakers in position.

8. A vessel carrier as claimed in any one of Claims 1 to 6 in which the base plate is provided with a trough for receiving the lower part of an inserted beaker or beakers.

9. A vessel carrier as claimed in any one preceding Claim in which the stirrup is dimensioned to simultaneously receive and carry a plurality of beakers and/or vessel holding frames.

10. A vessel carrier as claimed in any one preceding Claim in which the stirrup is arranged to receive a beaker dimensioned to simultaneously receive and hold a plurality of vessel holding frames.

11. A vessel carrier as claimed in any one preceding Claim in which the beaker or beakers is/are formed of plastics material resistant to chemicals.

12. A vessel carrier as claimed in Claim 11 in which a pair of opposite side walls of the beaker is formed with grooves to receive the arms of the stirrup.

13. A vessel carrier as claimed in any one preceding Claim in which the beaker or beakers is/are formed of transparent material.

14. A vessel carrier as claimed in any one preceding Claim in which the vessel holding frame has a hollow body and a substantially cube or cuboid shape formed with the openings or windows in the side walls thereof, the frame has a base and a solid upper part formed with substantially perpendicular through bores disposed in rows, and each bore is arranged to receive a test vessel therein.

15. A centrifuge in combination with a vessel carrier as claimed in any one preceding Claim in which at least one photo convertor is mounted above a trajectory traced by the vessel carrier when the centrifuge is in use and corresponding to said photo convertor is a stroboscopic lamp disposed below said trajectory and arranged to emit light in flashes or pulses at a frequency adapted to the speed of centrifuging.

16. A centrifuge as claimed in Claim 15 in which the photo convertor comprises two groups of photo-cells, one group being responsive to bright-dark reflection and the other responsive to dark-bright reflection, and logic circuitry is arranged to give a control signal dependent on the responses of the two groups.

17. A vessel carrier for use in a centrifuge substantially as hereinbefore described with reference to and as illustrated in Figs. 1 to 6 and 9 to 11.

18. A centrifuge in combination with a vessel carrier as claimed in any of Claims 1 to 15 or Claim 17.

19. A centrifuge in combination with a vessel carrier substantially as hereinbefore described with reference to and as illustrated in Figs. 1 to 12.

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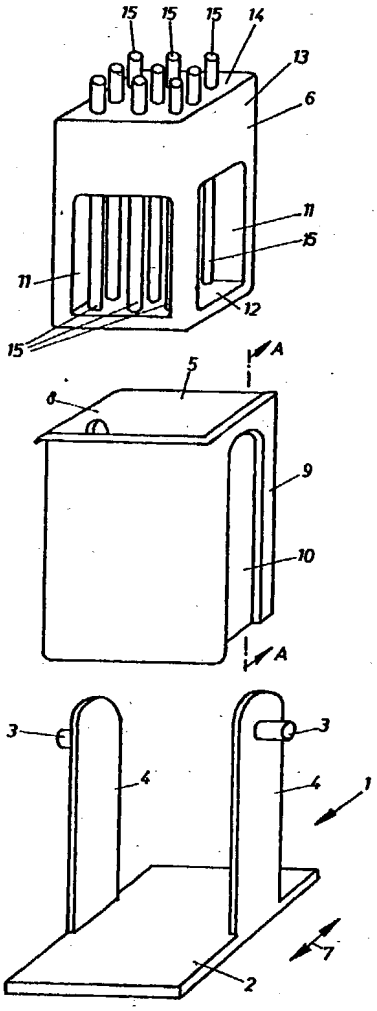

Fig.1

Fig. 2

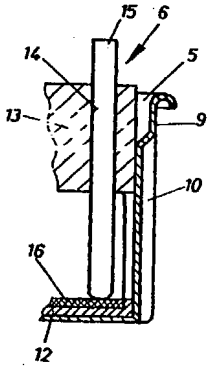

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Fig.3

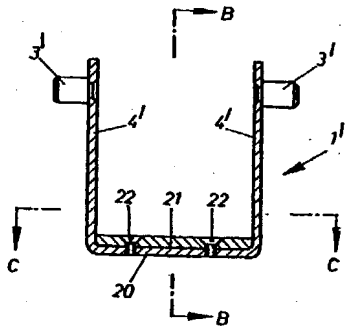

Fig.4

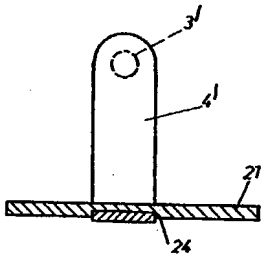

Fig.5

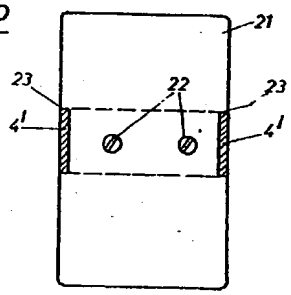

Fig.6

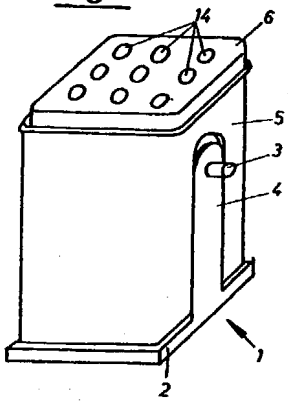

Fig.7

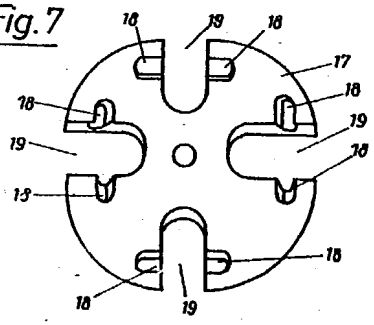

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Fig.9

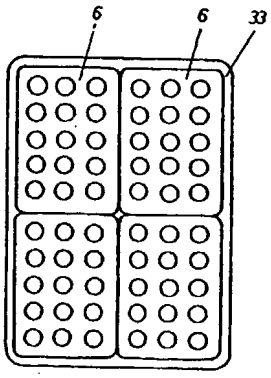

Fig.8

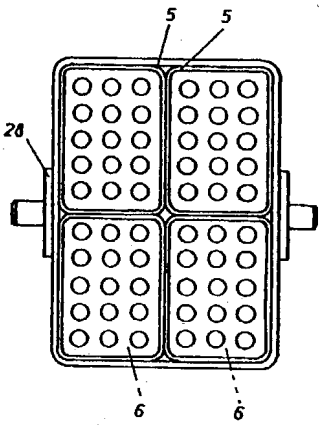

Fig.10

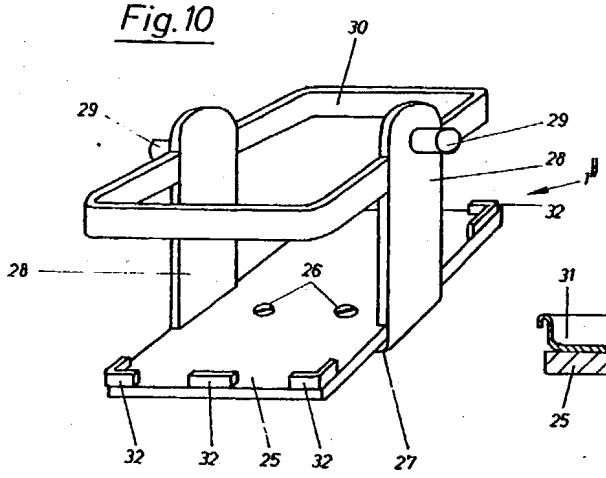

Fig.11

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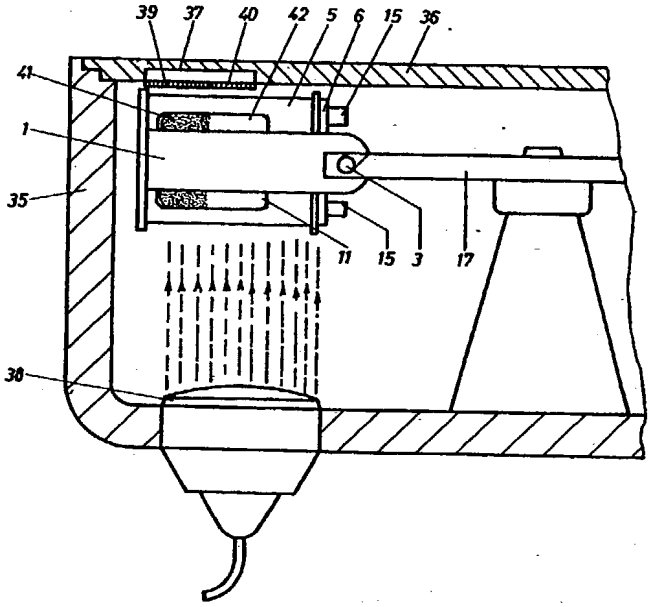

Fig. 12